The Impact of Changes in Transportation and Commuting Behaviors During The 1996 Summer Olympic Games in Atlanta on Air quality and Childhood Asthma

Michael Friedman, M.D.

Air Pollution and Respiratory Health Branch

National Center for Environmental Health

Centers for Disease Control and Prevention (CDC)

Health Effects of Air Pollution: A Broader Perspective

- How Much Do We Value Our Health?
- Where Do We Place the following on our Personal and Public List of Priorities?
  - Health
  - Convenience
  - Cost of Living
  - Personal Control

Health Effects of Air Pollution: An Overview of Scientific Evidence to Date

- **Strong Evidence of Pollution Exposure linked to:**
  - **Excess Mortality in elderly**
    (most heart and lung related deaths)
  - **Hospital admissions for heart and lung problems**
  - **Asthma exacerbations**
  - **Bronchitis symptoms**

Health Effects of Air Pollution: An Overview of Scientific Evidence to Date

- **Limited Evidence of Pollution Exposure linked to:**
  - **Infant mortality**
  - **Birth outcomes**
    (low birth weight, prematurity, congenital heart defects)
  - **Development of asthma and/or allergies**
  - **Childhood cancers (leukemia)**
  - **Heart attacks and heart arrhythmias**

Health Effects of Air Pollution: An Overview of Scientific Evidence to Date

- **No Well-Designed Studies of Potential Effect of Acute and/or Chronic Pollution Exposure on:**
  - **Mental Health Problems (depression, anxiety)**
  - **Aging**
  - **Immune System function**
  - **Neurodevelopment**
  - **Fertility (male and female)**

Health Effects of Air Pollution: The Role of Individual Pollutants

• PM_{10}	Elderly and infant mortality, asthma flares hospitalization for heart/lung problems
• $PM_{2.5}$	Elderly mortality, asthma flares, ??
• Ozone (O_3)	asthma and bronchitis symptoms, CHD?, ??
• Carbon Monoxide (CO)	Heart attacks ?, CHD ?
• Sulfur Dioxide (SO_2)	Bronchitis, cough symptoms
• Nitrogen Oxides (NOx)	Breathing problems, lung function decrease
• VOCs (i.e., benzene)	childhood leukemia ?
• Heavy Metal Oxides	??
• Mixture of Pollutants	asthma flares, ??

CDC

Health Effects of Air Pollution: Methods Used to Uncover the Facts

• Natural Ecological	London Smog Episodes of 50's, Mt. St. Helens Eruption, Forest Fires
• Time Series	Link health outcomes to day-to-day changes in exposure
• Cross Sectional	Link prevalence of health problem to one-time exposure assessment
• Longitudinal Cohort	Link measures of exposure periodically over time to onset of health problem(s)
• Intervention Ecological	Study health changes related to a man-made intervention which changes air pollution exposure… examples- closure of a small town steel mill, traffic reduction strategy for 1996 Olympics

CDC

Link Between Air Quality and Asthma

- **Epidemiological Time Series Studies:**

  Association between high ozone and/or particulate levels (PM_{10}) and acute asthma exacerbations

- **Laboratory Studies**

  Using human lung washings/cells or animal models

- **Experimental Studies**

  Exposure volunteers to various concentrations of pollutants and measure lung function changes

Link Between Asthma and Automobiles

- Only a few studies reported in literature
- Most studies report a positive association between traffic density on street of residence and either:
  - Frequency of asthma events
  - Prevalence of asthma among school-aged children
  - Symptoms of chronic bronchitis/cough but not doctor-diagnosed asthma

Air Quality and Asthma: Unanswered Questions

- No study to date has examined the impact of improved city-wide automobile congestion on asthma rates

- Need for alternatives to time-series methodology
  - study cumulative effect over time
  - measure potential synergy of exposure to multiple pollutants
  - de-couple pollutant levels and weather change
  - specifically examine impact of emission-lowering interventions

- The 1996 Summer Olympic Games in Atlanta provided such an opportunity

CDC

Preparations in Atlanta for The 1996 Summer Olympic Games

- "All eyes to be on Atlanta"
- 1 million plus visitors ….
  severe traffic congestion….
  problems getting to Olympic venues
- Plan developed to alleviate traffic worries

Atlanta's Plan to Control Automobile Traffic Congestion during the 1996 Summer Olympic Games

- Expand and encourage use of public transportation
  - 24-hour a day bus and rail service
  - 1000 additional buses for park-and-ride services
  - free use for Olympic event ticket holders

- Promote alternative commuting practices that emphasize shifting travel demand out of the rush hour periods

  i.e., telecommuting, flextime, staggered work hours, altered delivery and pick-up schedules, carpooling

CDC

Atlanta's Plan to Control Automobile Traffic Congestion during the 1996 Summer Olympic Games

- Media warnings of potentially-severe traffic congestion
- Highway improvements
  - road widenings
  - creation of high-occupancy lanes
- Traffic restrictions within Olympic ring/downtown area

Our Basic Study Questions

- Did Atlanta's traffic strategy really work?
- What impact did this have on air quality?
- What impact did this have on asthma exacerbation rates?

The Olympic Asthma Study: Methods

- **Ecological study design**
  - **comparing the 17 days of the Olympics to the 4 weeks before/after (baseline)**
- **Data Collection:**
  - **Acute care visits for asthma (first ICD9 = 493)**
  - **All non-asthma acute care visits**
  - **Levels of individual air pollutants**
  - **Meteorological conditions**
  - **Vehicular traffic counts**
  - **Monthly gasoline sales via statewide gas tax records**
  - **Public transportation usage**

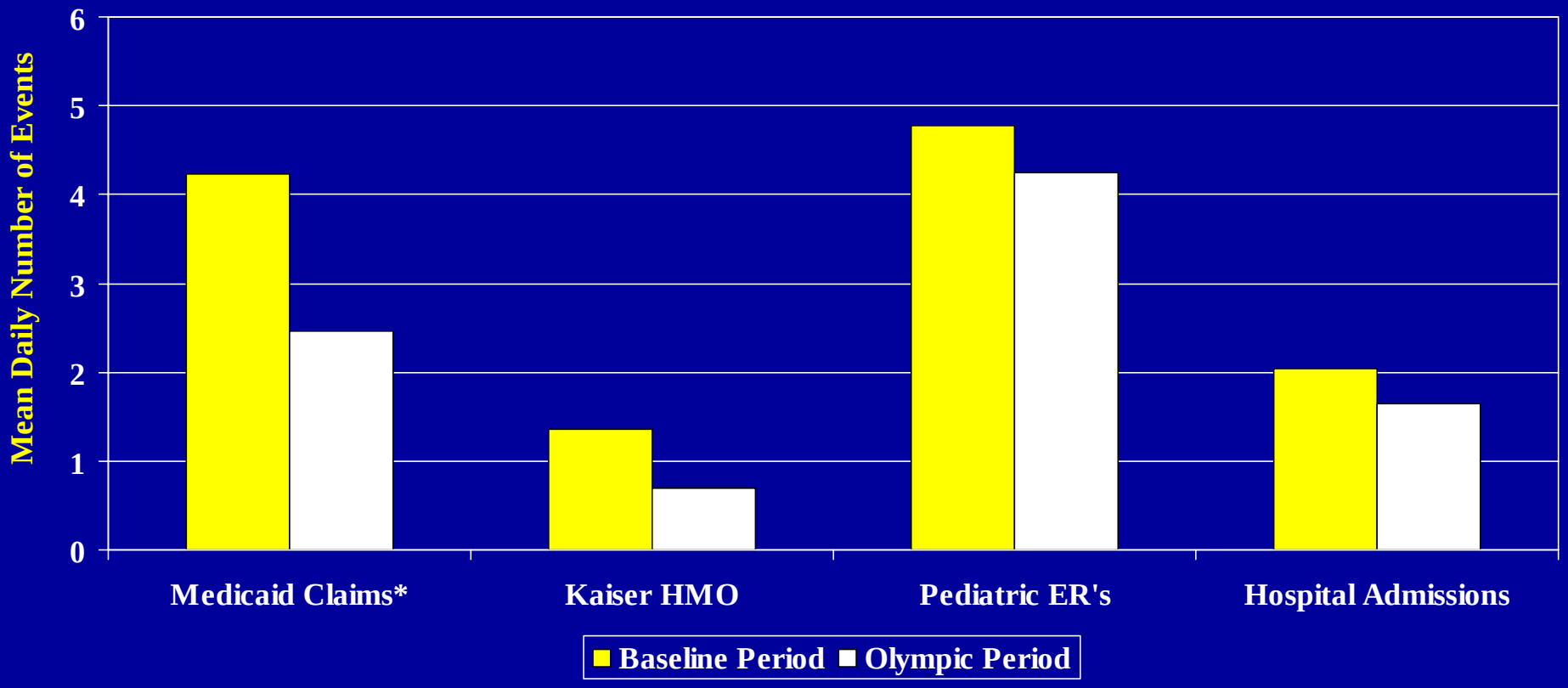
CDC

Methods: Sources of Medical Data

- Georgia Medicaid files (ER visits only)
- Kaiser HMO (ER and urgent care visits)
- ER records of 2 Pediatric Hospitals
- Georgia Hospital Discharge database

note: study population included all 1-16 year old residents of the 5 most central counties of Atlanta

Results: Acute Care Visits for Asthma
1-16 year old residents of Atlanta

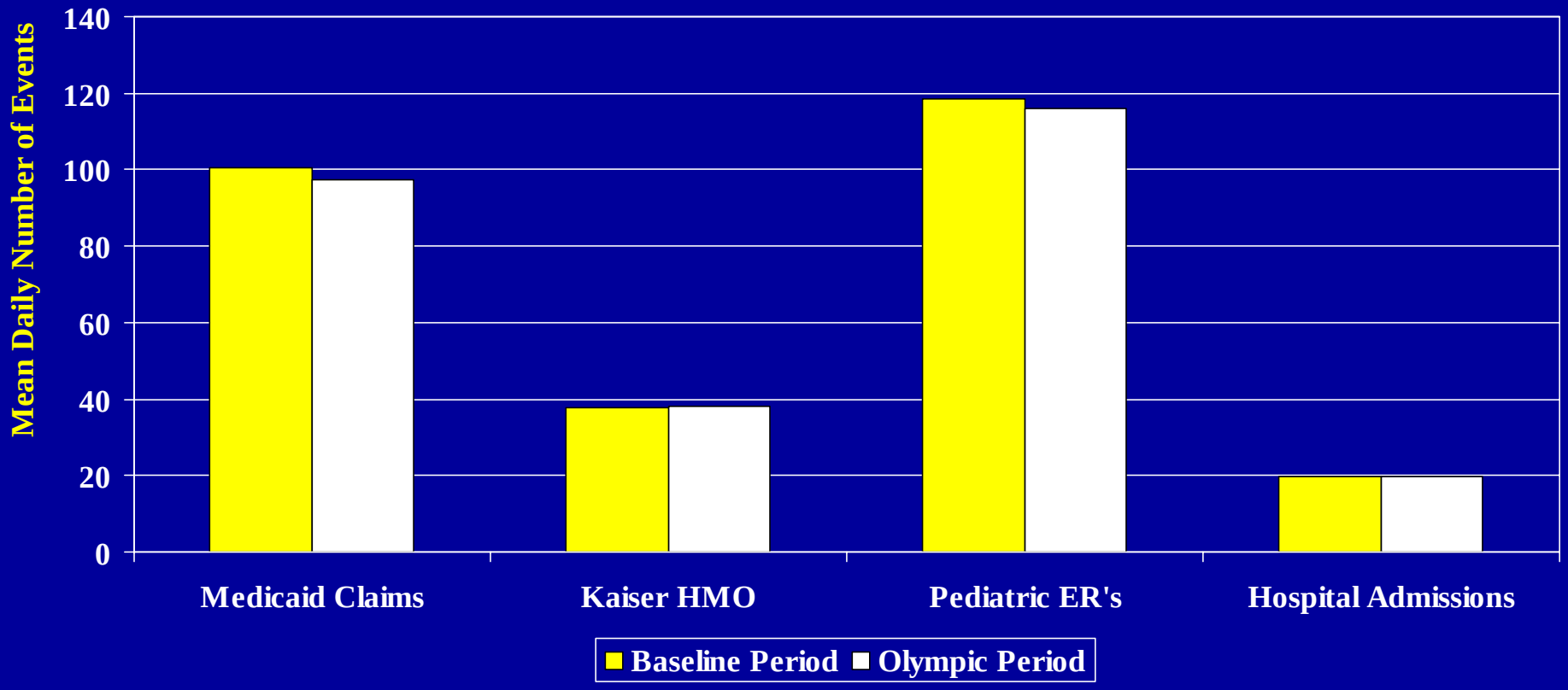


* p = 0.01

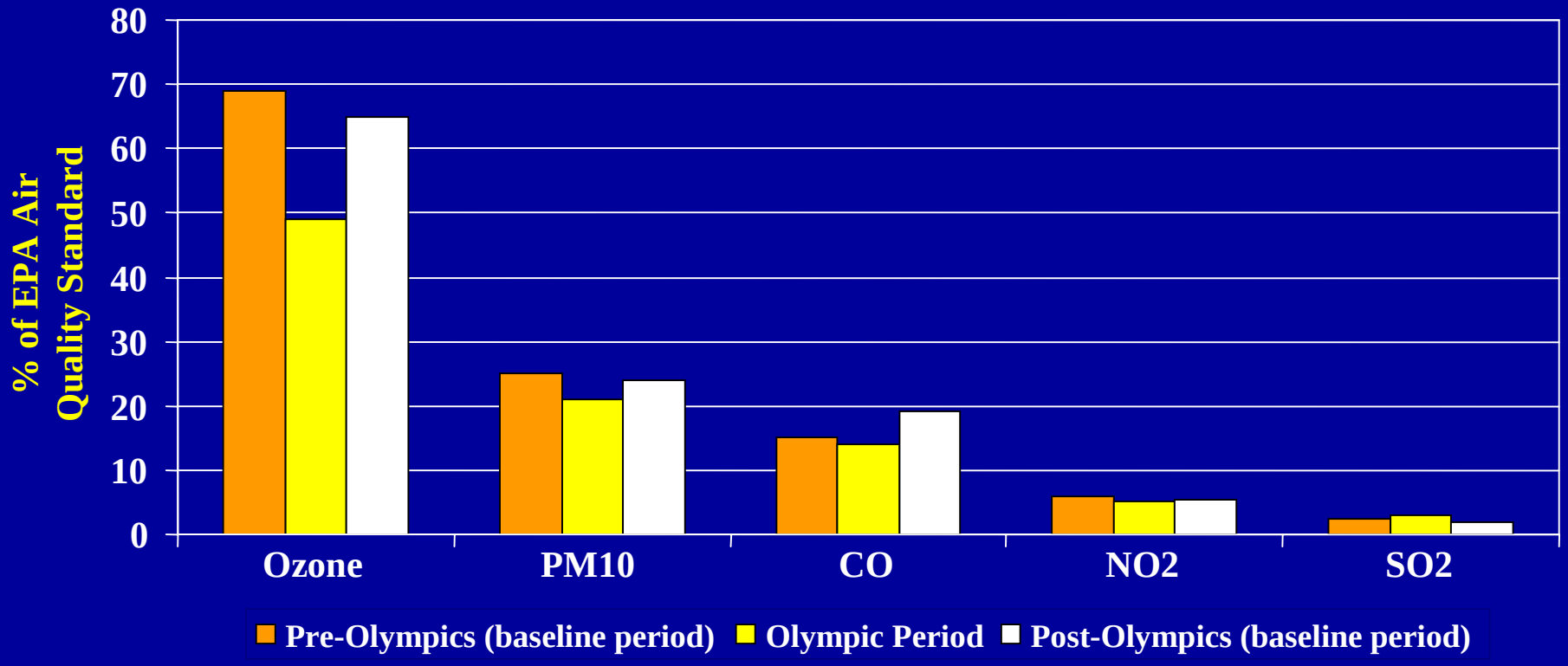
CDC

Results: Total Non-Asthma Related Acute Care Visits

1-16 year old residents of Atlanta

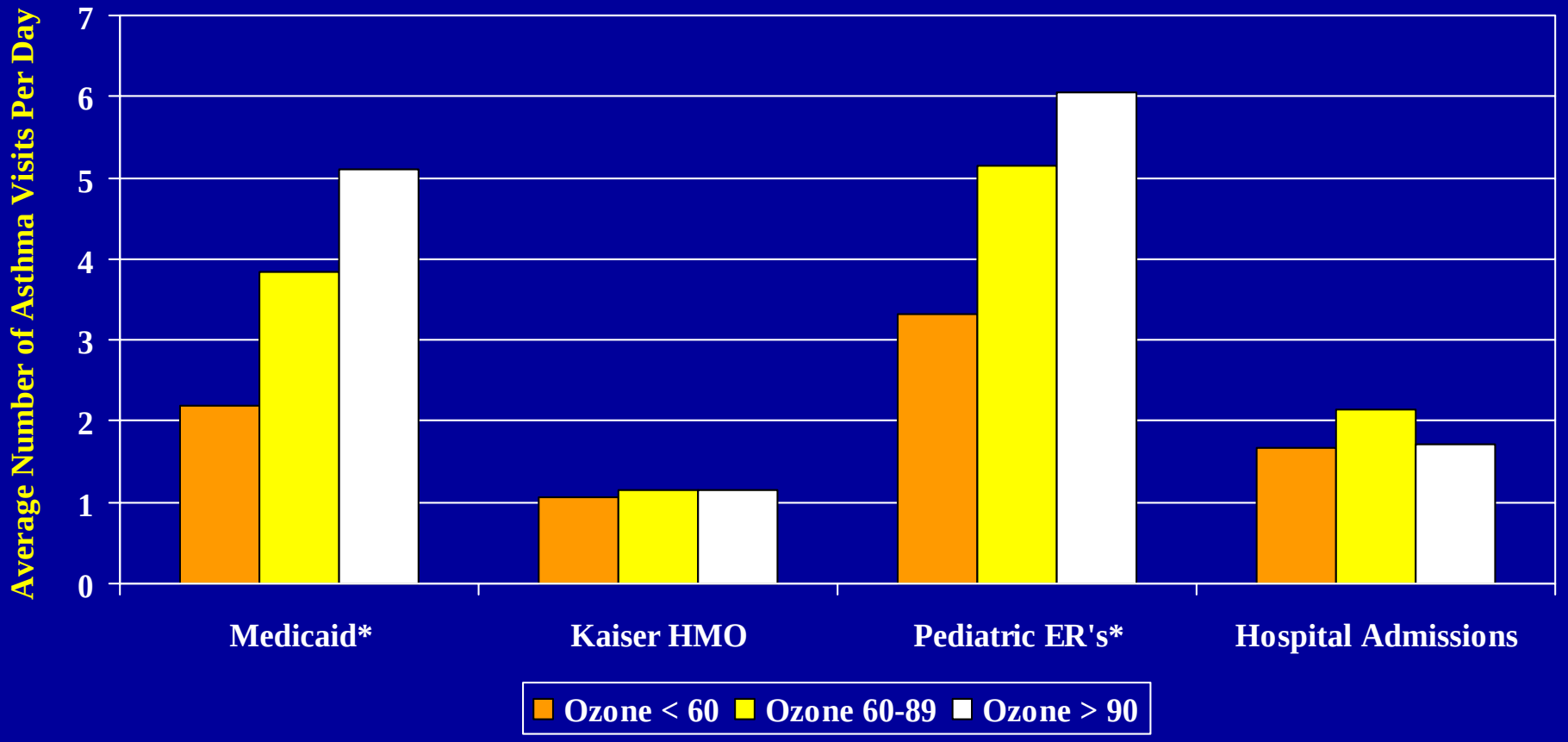


Mean levels of major pollutants before, during, and after the Olympic Games as a percentage of the EPA's National Ambient Air Quality Standard (NAAQS) for that pollutant[1]



[1]NAAQS at time of study: ozone = 120 ppb; particulate matter < 10*um* (PM_{10}) = 150 ug/m^3; carbon monoxide (CO) = 9 ppm; nitrogen dioxide (NO2) = 600 ppb; sulfur dioxide (SO2) = 140 ppb

The relationship between acute asthma events and ozone concentrations averaged over the 3 days preceding the event



* p < 0.01

Results: Why Air Quality Improved

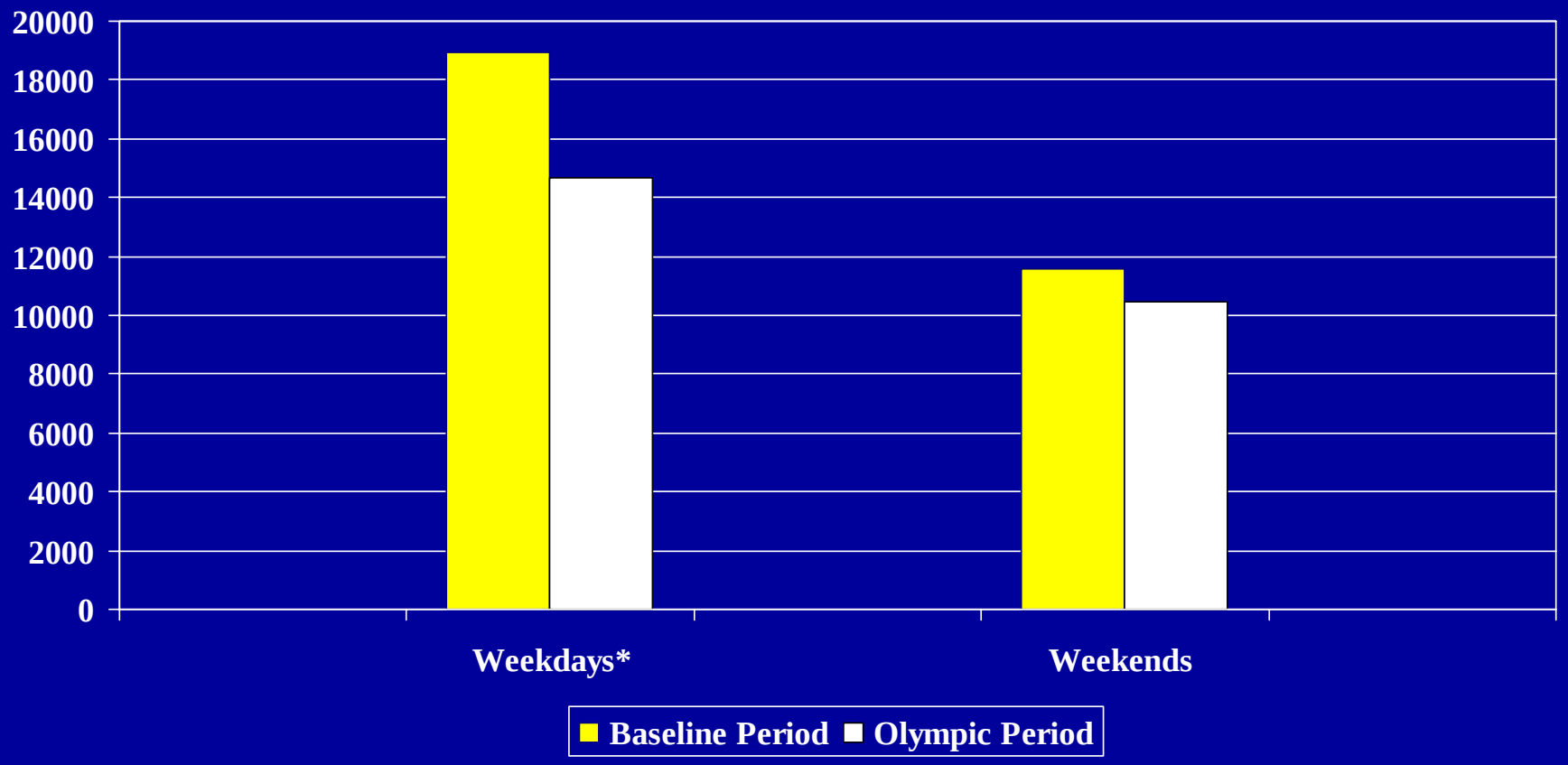
- Pollution Levels = Rate of Pollution Formation
  minus
  Rate of Pollution Escape

- Pollution Formation
  Automobile, Power plant, Factory emissions

- Pollution Escape
  Meteorological conditions, Geography

Results: 1-hour AM Peak Traffic Counts

daily average for all roads

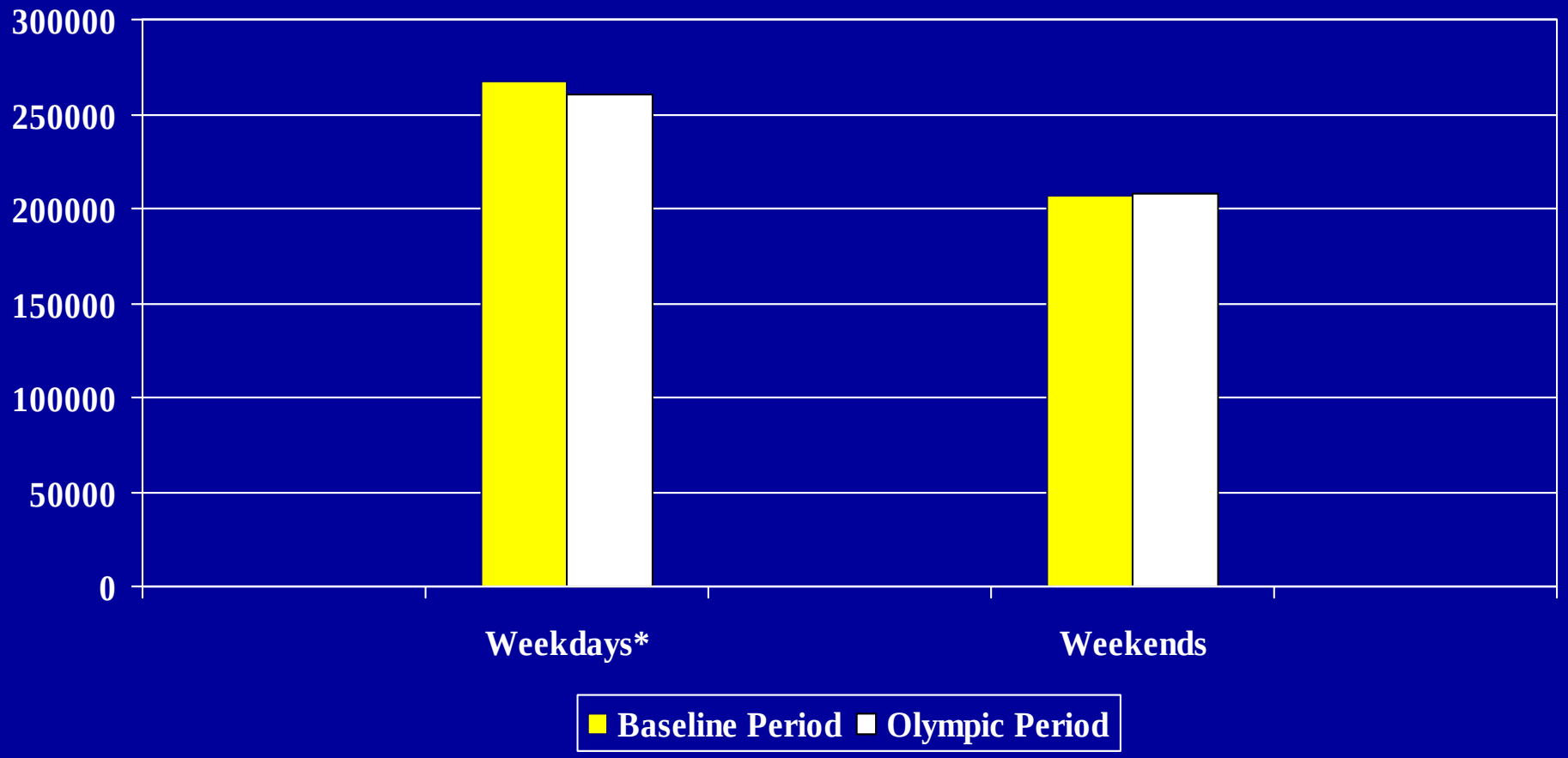


* p < 0.0001 for all 4 roads

CDC

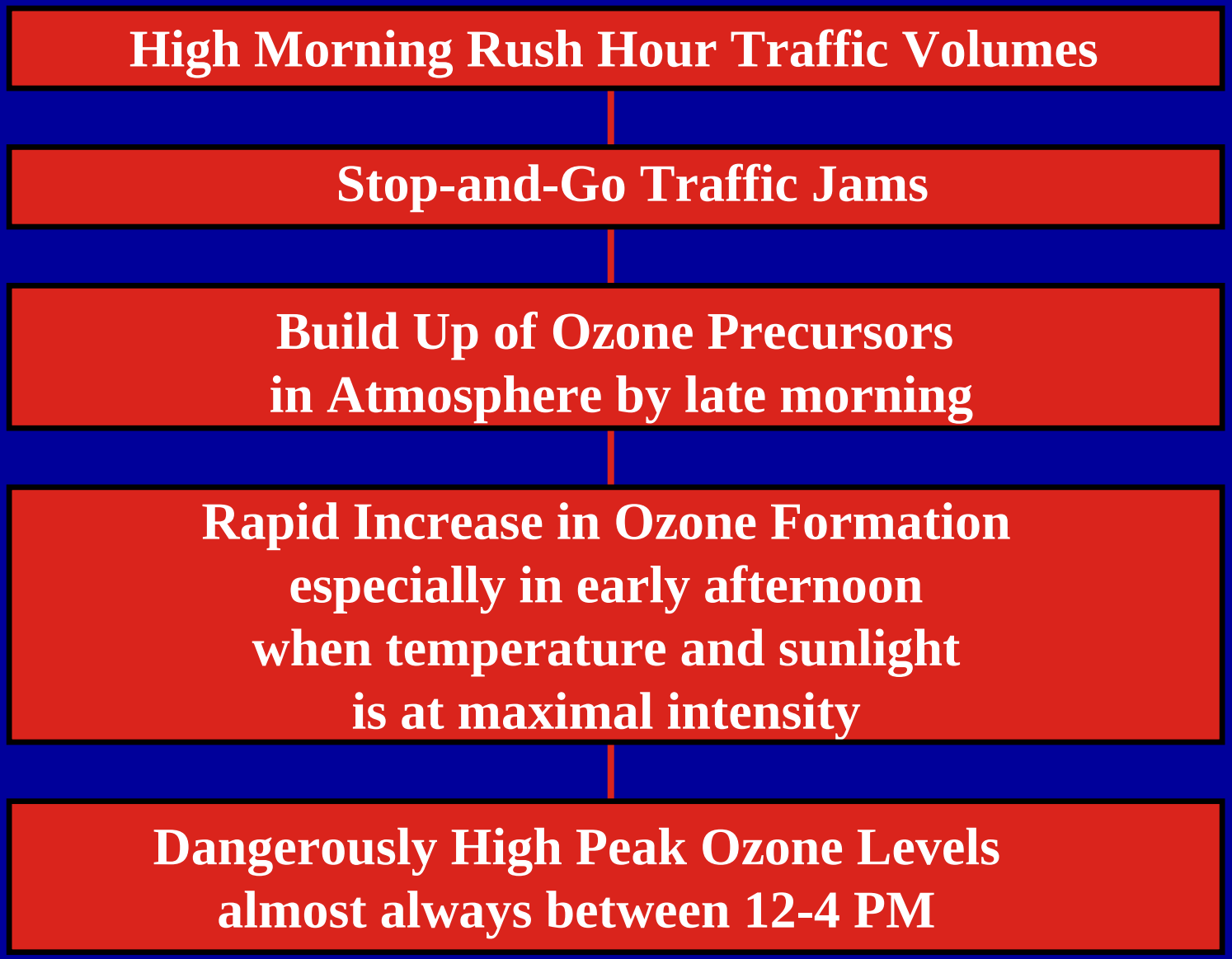
Results: 24-hour Total Traffic Counts

daily average for all 4 roads combined



* p < 0.05 for 2 of the 4 roads

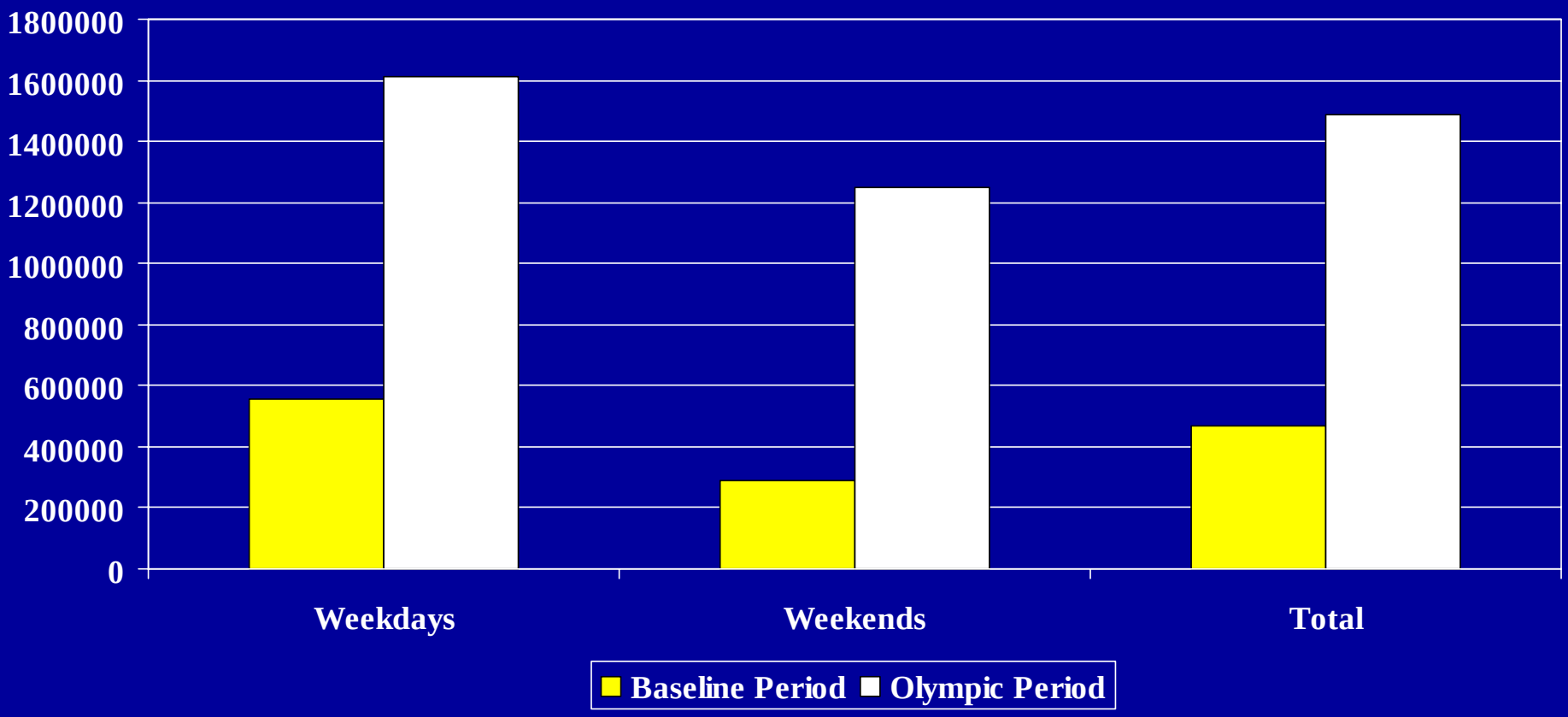
Results: Morning Rush Hour and Ozone Formation



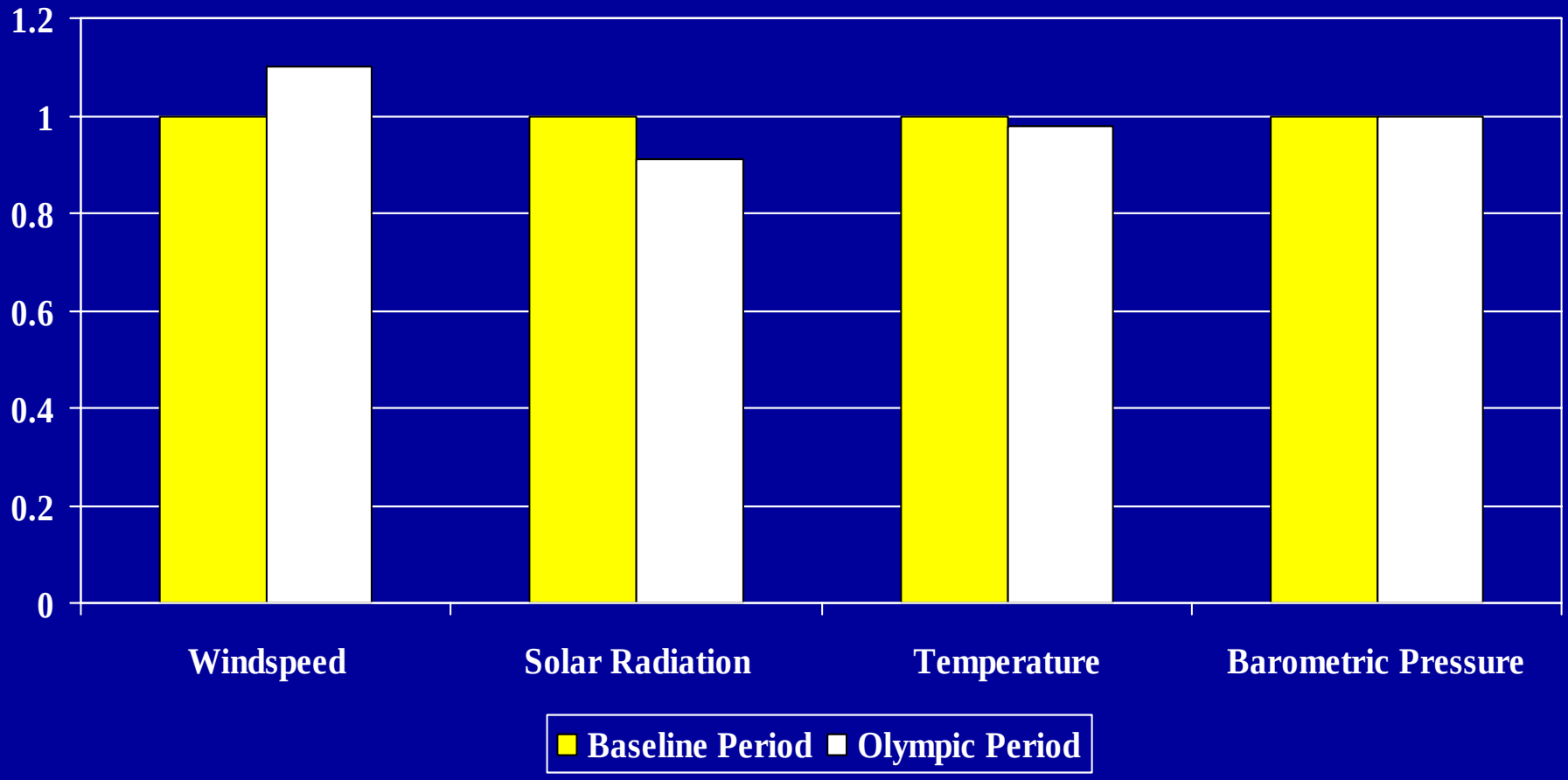
CDC

Results: Public Transportation Ridership

Number of rides per day



Mean Daytime Meteorological Measures During The Olympics Relative To The Baseline Period



Other Evidence Favoring Traffic Changes as the Cause of Improved Air Quality

- Ozone concentrations decreased more in Atlanta than 3 other Georgia sites with similar weather patterns (28% vs. 11%, 17%, 18%)
- Carbon Monoxide concentrations decreased 18% during the Olympics
  - levels much more dependent on automobile emissions than weather
- Sulfur Dioxide concentrations increased 22%
  - consistent with increased use of diesel powered buses and generators
  - should not have increased if weather conditions favored good air quality
- Positive correlation between weekday AM peak traffic counts and that day's peak ozone concentration

  (*r* using roads 1 - 4 = + 0.29, 0.42, 0.34, 0.39 respectively)

CDC

Olympic Asthma Study: Conclusions

- Measurable short-term changes in transportation and commuting occurred, leading to improved air quality, and fewer asthma exacerbations in Atlanta's children

- Limitations of study: short intervention period
  special nature of the Olympics

- Implications: innovative urban transportation and commuting strategies aimed at decreasing peak hour automobile use and increasing traffic flow may substantially improve the respiratory health of its citizens

CDC

Acknowledgements

- Rafael Balagas — Georgia Environmental Protection Division
  Bill Murphy
- Darren Palmer — U.S. Environmental Protection Agency
- Dennis Tolsma — Kaiser-Permanente
  Deborah Griffin
- Gene McDowell — Scottish-Rite Medical Center
- W. Gerald Teague — Egleston Children's Hospital
- Phil Harris — Georgia Department of Medical Assistance
- Dale Shuirman — Georgia Department of Revenue
- Chris Porter — Cambridge Systematics
- The Georgia Department of Transportation
- The Atlanta Allergy and Asthma Clinic
- Metropolitan Atlanta Rapid Transit Authority (MARTA)

The Next Step: Reasking the 3 Basic Study Questions

- Can traffic reduction and/or emission reduction strategies work, and if so, how?
- What impact will this have on air quality?
- What impact will this have on health?

  i.e., asthma development or exacerbations, death rates among the very young and old, etc.

The Next Step: Understanding Transportation-Related Behavior Change

- The Olympic example

  large scale, non-sustainable change in routine behavior due to:

  traffic and parking fears

  eagerness to help city image (Olympic spirit factor)

  temporary change in social norms

- Role of Infrastructure Development in Priming Behavior Change
- Role of Promotional Campaigns
- Role of Regulations (Government or Corporate)

  i.e., parking restrictions, gas taxes, HOV lanes, flextime requirements

- Role of Personal and Societal Values

CDC

The Next Step: What You and I can Do

- Look for research and outreach opportunities to make the science as clear as possible to the public
- Advocate for city-wide policy and practice changes

  examine your city's traffic control strategies
  promote public transportation, AFVs, bicycling
- Re-examine vehicle emission standards (gov't or corporate) in an age of rapidly improving emission control technology and cost reduction
- Practice What You Preach

  bike or carpool to work, use public transportation, buy a low-emission vehicle, change lifestyle, etc.

CDC